

Campus Lighting Project

Charlie Smyth, 12/5/07 (note: I haven't confirmed every link but a working version can be found on my web site at: <http://www.charliesmyth.org/docs/lighting.html>)

Gary Cziko's presentation on lighting in campus town, <http://www.uiuclights.notlong.com>, has raised a number of interesting points and generated quite a bit of discussion in the community. There are some long term issues and implications about choices made so I think it's important to discuss them now before we commit ourselves to something that will last many years. We have many examples of communities that have taken steps that have huge payoffs 10 and 20 years down the road.

I think this effort can be couched in terms of having our cake and eating it too -- you can satisfy all sides. Even though there's lots of evidence about the effectiveness of lighting on the reduction of the fear of crime and the lack there off of lighting with respect to crime (See references below), I don't think it's worth much time arguing this because we know effective lighting is good for business, gets people out on the street, and makes pedestrians visible to vehicles in busy locations.

More importantly, from a public point of view, there's clearly money to be saved by going the LED route. I feel strongly that the cities and the University should not go forward with any more lighting until they can use LED's. Proper, effective lighting (and this is the word I think we should all use), can both enhance appearances of safety and can probably make things safer for vehicles and pedestrians, particularly at intersections. At the same time, properly designed lighting is not light polluting. Full cutoff fixtures are not a big deal and should be required across the board. You don't have to turn night into day. In fact, it's not even healthy to do so, with more evidence suggesting a link to incidences of cancer released last week.

I am intrigued at the possibility of balancing the combinations of lights used in LED's to enhance night vision. I think this is a real selling point. We have examples of cities that have saved money and the industry is maturing quickly with LED's appearing in many useful places.

This document is an amalgamation of emailed research and ideas by those listed below and I want to thank them for all that we have to work with here.

LED Lighting

Take a look at the DarkSky.org website. They rate and list appropriate light fixtures that avoid light pollution. The brightness of the light has to match the pole height to provide adequate lighting for the activity (usually measured in foot candles or lux). There are a lot of LED Streetlights available: <http://www.darksky.org/> and <http://www.darksky.org/lighting/> in particular

Illuminating Engineering Society of North America is the body that sets the lighting standards for different activities. <http://www.iesna.org/>. They have lists of LED light manufacturers also.

Here's the only manufacturer listed on the IESNA site for LED lights, on high poles: <http://www.lithonia.com/NightTimeFriendly/AreaLuminaires.asp>

Dark-sky friendly lighting products are linked to at the bottom of this page:

<http://www.darksky.org/programs/fixture-seal-of-approval.php>

Deb Lovig (CREE, Deb_Lovig@cree.com) wrote:

We make only the LED components, not the full fixture. I am attaching a list of LED fixtures makers we can recommend. I don't know if they are IDA approved but they are very good fixtures. I hope this is helpful. www.ledcity.org/fixture-contacts/html

Most of the LED fixtures makers offer poles of different lengths or an attachment option for an existing pole. It's best to contact several directly to get product specs and comparison information.

We simply attached LED fixtures to existing poles in our parking lot last month. However, the new pole designs are very nice and if you are buying poles anyway, I'd look into the options from the LED makers.

Light Pollution Issues

Local articles on light pollution with a nice introduction to the various aspects of good and bad lighting:

<http://environmentalalmanac.blogspot.com/2005/03/light-pollution.html> and
<http://www.astro.uiuc.edu/~uias/lightpollution/>

These local photos make the point very well:

<http://www.astro.uiuc.edu/~uias/lightpollution/pics/panorama/>
<http://bi-staff.beckman.uiuc.edu/~melockwo/lp/lp.html>

New Yorker article on light pollution: http://www.newyorker.com/reporting/2007/08/20/070820fa_fact_owen

Website on light pollution and measures to combat it from a California perspective: <http://www.skykeepers.org/> includes links to municipal codes in California, such as Oakland's requiring full cut-off luminaries and glare reduction.

Look at some of the photos of dark-sky friendly lighting here:

<http://www.darksky.org/programs/awards-2005.php>

LEED explanation (Annette Stumpf)

LEED (Leadership in Energy and Environmental Design), the green building rating tool developed by the US Green Building Council has a credit if you avoid light pollution. Each credit has an "intent" (tells you what is important), "requirements" (how to calculate if you've earned the credit or not) and "technologies strategies" (how to earn the credit).

There are several rating tools. For the LEED-NC (New Construction) tool, the credit is Sustainable Sites Credit 8, Light Pollution Reduction. Here's a link to LEED-NC rating tool:

<http://www.usgbc.org/DisplayPage.aspx?CMSPageID=220>

(see page 23 of this file: <http://www.usgbc.org/ShowFile.aspx?DocumentID=1095>)

But the draft version of LEED-ND (Neighborhood Development) is probably even more relevant.

<http://www.usgbc.org/DisplayPage.aspx?CMSPageID=148>

For this rating tool, we care about "Green Construction and Technology credit 20 - Light Pollution Reduction".

(see page 141 of this file: <http://www.usgbc.org/ShowFile.aspx?DocumentID=2845>)

Lighting and Safety Studies

An interesting paragraph from <http://www.darksky.org/resources/information-sheets/is027.html>

“It appears that at Wesleyan there is no statistically significant evidence that outdoor lighting forms any deterrent to crimes of sexual assault. This supports the similar findings at a national level by a number of studies; the best known of which is probably the National Evaluation Program, Phase 1 Report, funded by the Law Enforcement Assistance Administration, U.S. Department of Justice (see Information Sheet No. 63). The conclusion of that report is that "there is no statistically significant evidence that street lighting impacts the level of crime", although it is recognized that increased lighting of almost any kind, good or bad, reduces the fear of crime. It is in society's interest to realize that feeling safe and being safe are not always the same, and different solutions may be needed to satisfy each condition. I believe that society would choose to be safe rather than just feel safe.”

Some resources on crime and lighting:

<http://www.darksky.org/news/newsletters/50-59/n159.html>

US Department of Justice Study: <http://www.darksky.org/resources/information-sheets/is063.html>

<http://www.darksky.org/resources/information-sheets/is051.html>

<http://crimeprevention.rutgers.edu/brochures/lighting2/lighting.htm>

More British and American studies:

<http://www.homeoffice.gov.uk/rds/prgpdfs/fcpu28.pdf>

<http://www.britastro.org/dark-skies/crime.html>

<http://www.crimereduction.homeoffice.gov.uk/burglary/burglary45.htm>

http://informedesign.umn.edu/Rs_detail.aspx?rsId=1548

http://www.astrolab-parc-national-mont-megantic.org/data/pollum/Lighting_and_crime.pdf

<http://www.popcenter.org/Library/CrimePrevention/Volume%2010/index.htm>

<http://bjc.oxfordjournals.org/cgi/content/abstract/44/3/441>

<http://www.selene-ny.org/downloads/lightingandcrime.pdf>

<http://www.palgrave-journals.com/cpcs/journal/v5/n2/abs/8140143a.html>

<http://www.darksky.org/resources/links/crsesali> http://amper.ped.muni.cz/light/crime/lp040_1h.html (this particular study debunks many commonly cited references suggesting a significant lighting effect on crime deterrence. In fact, the major point here is that though the UK has made tremendous investments in lighting, crime is up 28 %.)

<http://www.maltastro.org/lpag/>

What other communities are doing

LED Streetlights meet IES street lighting standards.

February 17, 2004 - Series M400 CobraHead-Styled LED Streetlights shine light at ground level, eliminating unwanted glare, light trespass, energy waste, and sky glow. Containing 400 Warm Incandescent-White LEDs, cluster lamps draw 19 W, emit 3,200 K, and offer over 100,000 hr of life. Type 1 lamps have to be hardwired into cobra head fixtures, while Type 2 lamps feature male 39 mm mogul bases that screw into socket of fixture. Standard voltage is 120 Vac. **Related categories:** [Architectural and Civil Engineering Products](#)

Ann Arbor to install LED street lights downtown (Posted by [Tom Gantert | The Ann Arbor News](#) October 17, 2007 08:00AM) - Info on Ann Arbor's downtown LED plans:

<http://www.mlive.com/news/annarbornews/index.ssf?/base/news-24/1192632347246110.xml&coll=2>

Summary: Converting all its downtown lights will save the city \$100,000 a year in energy costs and reduce greenhouse gas emissions by the equivalent of taking 400 cars off the road for a year. Claim to be the first US city to move all downtown lights to LED light bulbs. Project will take 2 years at a cost of \$630,000. Mayor says that eventually, the entire city will have LED lights. The LED lights also provide better light quality for improved visibility and safety, according to LED City, an organization of government and industry parties that is promoting their use.

Raleigh, N.C., and Toronto are two other cities that have installed LED lights in their downtown according to [CREE](#), the company that manufactures semi conductors in LEDs but haven't committed to doing entire downtown.

The older street lights have a two-year life after which they all had to be replaced. The LEDs have a seven-year warranty and are expected to last as long as 10 years and don't contain mercury.

According to reports, roughly 22 per cent of the US's total energy production goes on lighting. LED City initiative, the joint industry-government working group, was set up in February 2007 in Raleigh, North Carolina, to promote LED lighting as a way of reducing this figure.

According to the US Department for Energy, if LEDs were widely adopted, the amount of energy spent on lighting could probably be halved. Over the border in Canada, Toronto's officials estimate that replacing its street lights with LEDs will save it \$6m a year in electricity costs, and cut CO2 emissions by 18,000 tons annually.

- Toronto's LED lights with photos: <http://www.ledsmagazine.com/news/4/3/1>
- Raleigh's use of LEDs (plus new video): <http://www.wral.com/news/local/story/1201312/>
- Calgary, Canada – a very early adopter planning to save millions: <http://content.calgary.ca/CCA/City+Hall/Business+Units/Roads/Street+Lights/Technical+FAQ.htm> and in particular: <http://content.calgary.ca/CCA/City+Hall/Business+Units/Roads/Street+Lights/EnviroSmart+Photo+Gallery+.htm>

From the Economist:

http://www.economist.com/business/displaystory.cfm?story_id=10214726&CFID=27917664&CFTOKEN=95242352

“Low-energy illumination is lighting up the Dutch electronics giant. THIS weekend the Italian village of Torraca proclaims itself the world's first "LED city", unveiling new streetlights that emit a bright, white and ecologically green glow. The new lights use light-emitting diodes (LEDs)...”

See photos of Torraca's lights at <http://www.cityledlighting.com/torraca/> .

Note: These are not full cutoff or even shielded lights. We can do much better here, LEDs and AND full cutoff.

ALAN WARREN/ANN ARBOR NEWS: The LED street lights provide a whiter light compared to the existing incandescent ones. Note that these have been fitted with something over the top half of the light to minimize light pollution.



Thoughts about lighting from Gary Cziko

I think the issue can be broken down into four components:

1. The directionality of the lighting: So-called "full cut-off" lights will direct the light down to the street reducing glare and light pollution. I don't see why we should even consider any lights that are not full cut-off lights.
2. The quantity of light: How bright do the lights need to be? Should be bright enough to safely see pedestrians, but not bright enough to read a newspaper except in spot locations such as bus stops and ATM's.
3. The quality of the light: This has to do with its color (temperature). Certain colors allow mesopic vision, which is a combination of night (scotopic) and day (photopic) vision. Fewer lumens of the right color can appear brighter than more lumens of the wrong color.
4. How the light is generated, i.e., the type of light bulb: LED may have higher initial cost but use about half the energy of high-pressure sodium lights and last much longer, about 60,000 (that is almost 14 years if burned 12 hours/day). LED also allows more control of the lighting.

Gary's five E's for lighting:

Here's a simple scheme of five criteria, each starting with "e." Our outdoor lights should be:

1. **Efficient.** Getting the most light per watt (lumens per watt).
2. **Effective.** Putting all the light where we want it--down on the ground. Not sideways causing glare and light intrusion. Not up causing sky glow. The color of light produced also has an impact on effectiveness, with some colors allowing a combination of day of night vision.

3. **Economical.** Total cost of purchase, installation, operation, maintenance, and bulb replacement. Fully shielded lights also put more light per watt on the ground allowing use of lower wattages per lumen.
4. **Ecological.** Affect on birds and insects. Minimizing greenhouse gas emissions. Reduce mercury contamination (LED lights do not contain mercury, unlike mercury-vapor and sodium-vapor lights). Reducing sky glow.
5. **Esthetic.** Should look nice.

Whether LED lights will be best to satisfy these criteria is open to research and discussion. And tastes vary concerning what is esthetic. But I don't see how or why there should be any debate about our lights being efficient, effective, economical and ecological, as described above.

Annette Stumpf adds the following: At a quick glimpse, I like the lights that Ann Arbor installed: http://www.treehugger.com/files/2007/10/asquared_michig.php. They look like a contemporary old-fashioned style.

But one person who commented on this blog didn't like them at all, and further down it says they don't have the cut-off optics. I'm not sure about either comment. It would take a while to go through all the details and figure out what lights you want to select based on performance characteristics.

That is probably what Urbana should establish - performance criteria/characteristics for the lights they want to install, and then someone can assess available light fixture design to identify the options. Finally, you can pick the lights that best meet your performance criteria.

One of the things we talk about with respect to lighting design is the "color" or spectrum of the light. Sunlight has a lot of red in it, and is considered a "warm" color. For instance, Warm White fluorescent bulbs are more popular in the north, and cool white are more popular in the south. Here's a chart showing the basic color temperature for typical lights: <http://www.ledwaves.com/pages.php?pageid=24>

You want to pick a light color that lets the eye distinguish colors. For instance, I remember hearing that it was hard to figure out what color cars were at night when Low Pressure Sodium lights were used (because they are very yellow and don't give very good color rendition).

I don't know what colors are available with the LED's so you'd have to ask the vendors what the color spectrum is. How well can people see the neighborhood and car colors with their lights? Here's an example spec sheet that shows the light distribution (in Lumens, measured on the ground), the cutoff angles (above 90 degrees) and the color spectrum: http://www.lumecon.com/docs/R20_11_8_2007.pdf and here's the webpage with the details: http://www.lumecon.com/led_street_lights.html

Another informative article: <http://www.patmullins.com/ledlightmyths.html> <http://www.patmullins.com/index.html> (disclaimer, I don't know this person, who pays him, or how credible he is, but the info I saw on his website looks reasonable to me..... but who knows).

There are lots of communities and companies and at least 9 federal agencies who have adopted LEED. The U of I uses LEED and I'm on a state committee that will adopt LEED for state funded buildings. Even the city of Normal Illinois has adopted LEED. <http://www.normal.org/Uptown/LEED.asp> <http://www.usgbc.org/DisplayPage.aspx?CMSPageID=1780> <http://www.usgbc.org/ShowFile.aspx?DocumentID=1741>

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